AC 2012-3435: RE-ASSESING THE EFFECTS OF SUMMER CAMP ON STEM ENROLLMENTS USING AN INNOVATIVE SURVEY STRATEGY

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Re-Assessing the Effects of Summer Camp on the STEM Enrollments Using an Innovative Survey Strategy

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Abstract

The Engineers of Tomorrow (EoT) program at West Virginia University (WVU), a National Science Foundation (NSF) supported STEP 1 project*, works to increase high school students' knowledge of and motivation toward science, technology, engineering, and mathematics (STEM) educational and career paths. Summer camps are offered in many NSF STEP 1 projects, but difficulties keeping track of summer camp participants in college or major are known. At WVU, it was recognized when EoT summer campers later enrolled in engineering, but we had no good way of tracking those students who enrolled in non-engineering STEM fields or in STEM fields at other universities. In this survey research, EoT summer camp alumni (2007-2011) were contacted via social media and e-mail using a personal invitation to participate in the survey. The invitation to participate came from an undergraduate engineering student camp counselor who was familiar to the campers, and this method is consonant with a research model we have established over the past 3 years. The invitation asked about how camp impacted their pursuit of postsecondary education and enrollment in STEM educational paths. Findings from this survey then were used to better understand the effect that summer camp has had on recruitment into all STEM fields. Survey data suggest that the number of students who enroll in STEM-related postsecondary education after attending EoT summer camp is higher than originally estimated. Three innovative methods were used to locate and survey summer camper alumni so we could estimate the larger impact, if any, of summer camp on engineering and STEM enrollments, and while we were moderately successful using these social media techniques, some unanticipated problems did arise using social media and these are discussed.

Introduction

Engineers of Tomorrow's (EoT) summer camp was implemented in late 2005 through funding from the National Science Foundation at West Virginia University. The goal of this program is to invite high school-aged students to campus and teach them a small portion of the career expectations and future applications of engineering. This summer camp focuses on hands-on projects which resonate with the Appalachian culture such as such as coal mine safety or generating green energy. Summer camp participants learn drawing software packages such as AutoCAD or ProENGINEER and they polish their skills on Microsoft Office programs such as Excel and Word. As of the summer of 2011 the camp has been run successfully for several years with the help of West Virginia University and undergraduate and graduate engineering students shoudering most of the day-to-day activities, consonant with our research model emphasizing peer mentorship. Aside of the academic content, the camp provides an important social opportunity where they are free to interact socially and
intellectually with other high school students from across the states of the Appalachia region. Maybe most importantly, the free-time conversations purposely allows high school students to be in the company of engineering students from the local area in order to fully grasp the availability of pursuing this type of degree and career path.

**Literature Review**

Careers in STEM are one route to improved economic stability in the Appalachian region and improved quality of life for families and their supporting economies. Yet, by almost any measure, the difficulties in attracting high school students to STEM careers are enhanced in Appalachia, and especially in West Virginia \(^1, 2\). Declining population with out-migration of college graduates and in-migration of less-than-high-school graduates characterizes this region. Over 20 percent of US residents have college degrees, but only about 14 percent of residents in Appalachia have college degrees with West Virginia the lowest state on this measure. The Appalachian region has high unemployment with West Virginia's McDowell county second highest in the late 1990s at 22.74 percent for men and 20.84 for women. One major industry in Appalachia, coal mining, employed 229,494 workers in 1980, but dropped to 99,801 jobs by 1996; the manufacturing sector in Appalachia lost 202,173 jobs in the same period. The poorest regions in Appalachia compete with more affluent states and Appalachian metropolitan areas in attracting the jobs of the future. The construction of West Virginia's "corridor highways", although conceived in the 1930s to improve economic development, are only now being completed and the impact of enhanced mobility on educational opportunities is still too new to measure.

As part of a project funded by the National Science Foundation, *Engineers of Tomorrow* sought to attract Appalachian-region high school students to careers in the sciences, technology, engineering, and mathematics (STEM), with particular emphasis on females and underrepresented minorities in engineering. One related project in EoT included, was designed to help high school teachers across the state develop on-line modules using engineering designs; these popular projects were linked to state teacher standards in order to make them more attractive to fit into a busy teacher's day. Our residential summer camp is where high school-aged girls and boys met and interacted with University engineering faculty, but more importantly, West Virginia engineering students who may have come from the same high school; this approach is well supported in the literature. Stout et al. \(^3\) suggested that contacts with same-sex experts such as advanced peers or instructors in STEM enhanced girls’ self-concepts, attitudes towards STEM, and motivation to persist in STEM careers. The use of same-sex experts provided a type of stereotype inoculation for female students. Teachers of either sex who understand STEM and how to support girls’ strengths in these areas are in an ideal position to facilitate access to these traditionally male-dominated fields. Research conducted at WVU suggests essentially the same thing: summer camp girls, more than boys, prefer same-sex peers in college visitation and in resolution of problems they may encounter at college \(^4\).

But disturbingly, evidence also points to the fact that fewer girls than boys show high science achievement, have positive attitudes and values toward science, and later choose science-related careers. Males and females may be differently affected by risk factors during school age and beyond \(^4, 6, 7, 8, 9, 10\). For example, motivation profile analyses show that females from grade six
to junior college are more self-determined, but less externally-regulated and motivated toward science-related activities than males \[^{10}\]. With respect to achievement in courses and more particularly on advanced placement exams, females are more likely to excel over male peers in language arts, and males are more likely to excel in science \[^{4, 6, 11, 12, 13}\]. Progress in addressing this problem is evident since striking gender inequities in education \[^{14}\] and the under-representation of women in science \[^{15}\] were illuminated decades ago \[^{16}\]. Nevertheless, marked areas of science education inequity remain \[^{17, 18}\]. Females have closed the gap on math and made significant progress on science components in national and international assessments such as National Assessment of Educational Progress (NAEP), Trends in International Mathematics and Science Study Results (TIMSS-R), and Programme for International Student Assessment (PISA) and in taking challenging science courses in high school, but still earn fewer advanced placement credits for college \[^{4, 18, 19}\]. Even though more females enter college with higher educational aspirations than males, fewer degree recipients in computer science, engineering, and some physical sciences are women \[^{18, 5, 20}\]. Yet it is possible that these deficits can be offset with a vibrant summer camp featuring the well-documented, numerous and rewarding career paths offered in engineering.

Over the years, we've noted in other manuscripts that as university faculty and people who live in Appalachia, it has been known anecdotally for years that most young people in our region, and particularly first generation college girls, are reticent to move away for college for a new job, or even to go to an engineering summer camp. This we have called the Invisible Fence Theory \[^{21}\], as if there is an invisible barrier to leaving their home. Some have said, in particular, "Morgantown is too big of a city for my parents to visit." Enrolled students, more girls than boys, have asked if they can go back and work in their tiny hometown and live near their parents after college. Among those that leave their rural communities and graduate from college, some give up promising jobs out of state to come back to their small hometown and work for half of their former salary.

Tang and Russ \[^{22}\] assign some credibility to the Invisible Fence Theory, noting that the following factors characterize rural Appalachian family norms as they influence educational and career decision-making:

- Extremely strong church and community ties; seek help first from family or local community members; mistrust of outsiders.
- Patriarchal socialization with gender-specific career choices. Career pursuits focusing on individual goals may not be acceptable if they surpass or conflict with family career stations.
- Preference for the concrete in career choices including site visits rather than reading or hearing about career options; preference for oral rather than written information.

Woodrum \[^{23}\] reported along these same lines that that "parents are distrustful of career education programs that prepare their children for opportunities not available in their home area, and that could require them to leave the family. Many [parents] feel they are in competition with the schools over the future of their children." Judging by the evidence presented by Tang and Russ, there may be some real basis for the "invisible fence" theory, even if the “fence” is more metaphorical than physical \[^{22}\]. If Appalachian parents do not want their children to move away
from home for work or for college, and if the children have no role models to suggest anything different, might there be a model for moderating that stress? How do these students learn about STEM and engineering careers? One possible answer is first-hand experience where high school students are met in the first minutes of camp by engineering students from the local area and maybe even the same high school, where the high school participants experience real residential college life during a week of total-immersion dorm living and lab work alongside these special peer mentors.

A well-known, robust model of drug and alcohol prevention known as the “Social Stress Model” [24, 25] was adapted and applied to enrollment data on STEM career pursuit in Appalachia. Lindenberg, Gendrop, and Reiskin [26] reviewed 35 studies using the social stress model of prevention, “According to this theory, the likelihood of an individual engaging in drug abuse is a function of the stress level and extent to which it is offset by stress modifiers such as social networks, social competence, and [social] resources.”

The model has been applied in West Virginia among inner-city youth as part of a drug and alcohol awareness program and as part of a helmet use and bicycle safety project [27, 28] and more recently to predict alcohol use among rural adolescents [29] and Hispanic immigrants [30]. The World Health Organization’s [31] Programme on Substance Abuse modified this model by adding cultural and environmental variables. We have also adopted this model for our summer camp.

This the social stress model was adapted for our summer camp evaluation work for three reasons: First, because of its broad acceptance and research base nationally and internationally; second, its adaptability to multiple modes of ecological stress encountered by youth; and third, its parsimony for understanding how youth adapt to their environments and make decisions. In our adaptation, the social stress model suggests that a community by itself, or schools by themselves, or family units by themselves, rarely have the resources, expertise, training, or wherewithal to support sound career decision making by youth. In impoverished and under-resourced Appalachian communities, the stressors are multiple and include poverty, out-migration, unemployment, low college completion rates, low family incomes, high dependency rates, major industries in flux, and isolation by geography [1, 2]. In this adaptation of the social stress model, we make heavy use of the influence of peers (e.g., engineering students) to help Appalachian youth make informed choices about careers, and about the value of a solid career option to their family, themselves, and their community.

Again, and as we've noted in other papers, these stressors apply in some measure in non-Appalachian regions, but are exacerbated in extensively rural and historically impoverished Appalachian communities. If this model holds, Appalachian social networks, social competencies, and social resources directed at making STEM-oriented career choices will need to be moderated by a phalanx of support and prevention methods. For example, among social stressors to youth pursuing a STEM career path, poverty and low college completion rates mean that youth will have few or no role models (e.g., friends, brothers, sisters, uncles, parents) to consult with about college living, dorm life, or how to selected courses, much less STEM or engineering careers. With out-migration and major industries in flux in Appalachia, youth may not know which industries are moving out of their area, and would have few sources of community expertise on careers that are growing, or offer high paying jobs not tied to
geography. Low family incomes mean that Appalachian youth have less opportunity to afford college, and with fewer adult role models and community resources, they may never learn about available scholarships and financial aid.

But what happens to summer camp participants after they leave camp and graduate from high school? Where do they go and into which disciplines? As part of our routine assessments, we could count the number of campers coming to College of Engineering and Mineral Resources at WVU, and we knew this number to be roughly 16 percent of campers each year. But we had to guess the number going to other STEM areas, to other Colleges at WVU and even to other Universities. We thought summer camp might have a broader effect, but we didn’t know for sure. So in this research project, we decided to try to reach former campers using social media, in this case Facebook, plus direct e-mails from camp applications to find out if campers went into STEM fields outside of Engineering, or just where they went. We also used two other novel ideas we thought would appeal to college-aged young people.

**Methods**

In accordance with a WVU-approved IRB protocol, we wanted to locate and then survey former campers using strictly virtual techniques that we thought would appeal to youth. First, the communication with past participants of EoT was conducted through direct e-mailing where we had e-mail addresses, and a more general approach, using Facebook, where we did not have e-mail addresses. E-mail invitations to take the survey were given to past participants of Engineers of Tomorrow summer camp held at WVU through the years spanning 2005-2011; in some cases, not unsurprisingly, e-mail records were incomplete, and so some former campers, about 25 percent, were unable to be contacted. Past participants were contacted via e-mail addresses provided on application information. This tactic was used to provide a way to ‘meet the kids at their own level’ by not forcing them to use a pen-and-paper, mail-back survey. It was the goal of our project to contact 200 previous participants in the EoT program via e-mail: a personal letter from the professors (the authors here) involved in the study was communicated to each student. In order to attempt to contact the past students without e-mail addresses, we put out a solicitation to past campers on Facebook and formally invited the students to participate in the survey. Whether the invitation came by e-mail or through Facebook former campers were asked by a former well-known camp counselor to navigate to SurveyMonkey (see: surveymonkey.com). We considered this a second important strategy that figured to make completion of the survey quick and to improve response rate. Once at Surveymonkey, the student could respond to a simple set of nine questions asking them to provide demographic information as well as educational choices and personal response questions based on choosing a field of study and changing majors (if applicable).

The third tactic in this study was the lure of a small random prize drawing for a handful of $50 iTunes gift cards which were offered to students who participated in the survey. Students were also asked to provide their e-mailing information in order to stay connected in future studies. If the student was under the age of consent (17 years old), it was suggested that they complete the survey with an adult family member and they were exempt from answering the questions posed about secondary education. However they still had the opportunity to provide contact
information in order to be entered in the gift card sweepstakes. We hoped these three innovations
were compatible with what we perceived to be young people’s current desire to use e-mail, social
media, and to download (legal) music, and also to be compatible with literature that suggested
the same \(^{32}\).

**Results**

Of an estimated 200 e-mail survey invitations and the more generalized approach through
*Facebook* sent to past camp students, 50 former campers responded to our survey, which
provided a response rate of 25 percent. This rate was found comparable to similar response data
for online surveys of 23 percent, according to a study done in 2000 \(^{33}\). Problems which were
likely to depress our observed response rate are discussed later.

Figure 1, below, shows the age groups of the students reporting data for this survey. A large
percentage (almost 40 percent) were not able to participate in questions three through nine in the
survey because they had not reached college in their academic career as yet. Those response data
are subtracted out leaving 30 responses reviewed further.

![Figure 1. Age Distribution in Data Reporting](image)

The number of male respondents to the amount of female respondents was almost 2:1 in favor of
the males. In summer camps between 2005 and 2011, the ratio of males to females in summer
camp has been variable but close to fifty-fifty. Gender distributions can be seen in Figure 2,
below.
The level of education of the responding students polled ranged anywhere from “less than high school” (i.e. dropped out of high school) to “graduate degree.” As shown in Figure 3 below, 95.5 percent of the students polled have at least a GED education with 63.3 percent of the students currently enrolled in college. A surprising fact shows that over 13 percent of the students who answered the survey have completed a bachelor’s degree and 4.5 percent have moved on to complete a graduate degree.

Figure 4 shows whether the student polled in the survey are still enrolled in a college or university. Since a very high percentage (over 88 percent) of campers on our end-of-camp survey
original indicated an interest in college while attending summer camp\textsuperscript{[34]}, the data here concurs; a large percentage of students (95.5 percent) are still enrolled in a university or city college or have graduated already. Only 4.5 percent stated they were not enrolled or attended secondary education.

In our survey, if the choice of college or university was one other than WVU, students were asked to provide the name of the school in which they were or have been enrolled. This was of particular interest as previous research was only able to track engineering students who enrolled at WVU. Other universities and colleges included the University of Pittsburgh, University of Pennsylvania (Penn), Massachusetts Institute of Technology (MIT), Georgia Institute of Technology (GA Tech), Pennsylvania State University (PSU), Snow College (Utah), and Marion County Technical Center and all of these were unknown to us prior to this survey, and we do not know if these were STEM enrollments or not.

In Figure 4, on enrollment in secondary education, similarly, and prior to this survey, our faculty only knew an estimated 16 percent of the campers enrolled in a WVU STEM career path after attending EoT summer camp\textsuperscript{[34]}. We were pleasantly surprised to learn that fully 45.7 percent of the respondents said that they went on to major in engineering or computer science, well above the 16 percent we knew of.

Finally, we discovered that we not only underestimated engineering enrollment for summer campers, but we learned that fully 75 percent of the students who took part in the survey said they had enrolled in a STEM related field. These majors included mathematics, physics, planetary sciences, engineering, chemistry and psychology. In Figure 5, the nine NSF-defined areas of STEM degree paths are highlighted showing seven STEM fields besides engineering. There is 59 percent above the 16% of former campers that we knew went into engineering alone.
Majors outside the STEM fields included sociology, anthropology, economics, exercise physiology, and business-related fields.

A set of final, open-ended questions were posed to the survey participants to better analyze how they go about making decisions for their future careers and major declarations. The first of these inquiries asked the students their reasons were for choosing their major and thus provided us a long list of personal responses suited to each student. Some of the notable answers given by the students were, “decent employment opportunities,” “I am reasonably good at math and science,” “From experiences at summer programs (i.e. EoT),” and “Because of my ____ (some family member) suggestion.” These responses were fairly anticipated for the STEM fields.

The students were asked about reasons for changing their major from one area of study to another in the final question of the survey. Most responses were anticipated, but 8 percent responded that they changed from one STEM field to another STEM field, flying in the face of conventional wisdom that students leave a STEM fields because it’s “just too difficult”.

**Conclusions**

There are obvious threats to any real utility of this study such as a low "n", the volunteer syndrome where people interested in your research are more likely to respond to it, and bad e-mail addresses (see below). We also lost a large number of respondents simply because they were still in high school. We also don’t know whether these results generalize the population of former campers. Finally, we realized that we needed a better method of tracking all campers for longitudinal research such as this. Still, the methods employed in the survey study attempted to use virtual media to reach young people at their levels of interest, and we think that alone is a success. First, we conclude that using social media, particularly Facebook, is an effective way to
reach back retrospectively and contact summer campers for survey reasons. There was no other real way to find campers if they were not part of engineering enrollments at our university.

Second, we conclude that *Surveymonkey* increased the response rate for the same reason, although we don't know how much: the survey was quick and easy to use by former campers, it arrived by e-mail, and it allowed for open-ended responses. Anecdotally, a few students contacted us outside the survey and told us they thought *Surveymonkey* was a good approach.

Finally, after discussions with undergraduate engineering students, we determined that the ITunes gift card drawing was the best incentive possible, and using it almost surely increased the response rate, but we don't know how much. Our informal focus groups suggested that offering several smaller prizes rather than one large prize provided a greater chance of winning a random drawing.

For five-plus years, our research team has had a nagging suspicion that summer camp was more effective than merely the traceable enrollments at our university, in engineering fields. It was previously known that WVU was enrolling about 16 percent of former camp participants, but didn't know to what university or discipline of study the rest of the former campers went. This tracking method did not even take into account if they even attended college at all. The new, updated survey method attempted to meet young college students at their own level using social media, a virtual survey instrument in lieu of written responses, and electronic gift cards as incentives.

We have three estimates of summer camp success:

- First, we conclude that there were 59 percent more students going into STEM fields than previously reported by WVU (75 percent 'STEM total', minus 16 percent 'engineering at WVU' = 59 percent 'all STEM' as suggested in Figure 5).
- Second, we found that 16.1 (32.1 all engineering minus 16 percent at WVU) enrolled in an engineering related field.
- Finally, a total of 75 percent of campers went into STEM fields of some kind at the college level.

These results suggest that summer camp is more valuable than previously believed, and can be counted as one of many important factors when high school aged students choose an education path and discipline of study.

**Recommendations**

There were drawbacks encountered when analyzing the data received in this particular study. One problem we did not anticipate but probably should have, was that young high school and college students who have a personal e-mail address will change it approximately once per year, judging from very small samples of student who responded anecdotally when asked that particular question. If this is true, then most campers would have changed their e-mail addresses once, twice and even three or four times since leaving camp, making them nearly impossible to contact directly by e-mail. This left only *Facebook*, or similar social sites to hold students’
interest in staying connected with the camp or activity, and this is true only if assuming the Facebook pages, or others, are updated regularly to retain interest.

Second, we found about 20 per cent of what we thought were valid e-mail address had parent/or guardian extensions associated with them ("Tomandsuzysmithfamily" as a fictitious example). After the study we realized that these e-mail addresses would be a dead end, and the invitation to participate in our survey after three or four years would probably be simply discarded instead of being forwarded. We should have anticipated this.

Overall, we are well satisfied that our selection of virtual methods raised the response rate because high school and college students are familiar to them. Even allowing for methodological concerns which we discussed here, we estimate that summer camp is much more useful as a way to influence STEM career decisions that we had thought. In fact, College-only enrollment information was a low estimate of engineering enrollment, and of no value estimating STEM enrollments.

Bibliography


End Notes

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